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Engineering AI into the Factory of the Future.

Five business imperatives to connect legacy machines, enhance workforce capabilities, and prepare for AI agents—while delivering ROI

Contents

Executive summary

The role of AI will be fundamental in the factory of the future. But it's not plug-and-play technology that can be switched on overnight. Deployments demand thoughtful planning and a clear roadmap.

This paper highlights five business imperatives that manufacturers should prioritize when aiming to roll out AI:

1. **Let business priorities lead technology decisions**

2. **Bring together data from new and legacy assets**

3. **Embed cybersecurity from day one**

4. **Prepare for autonomous AI agents**

5. **Enable workers to interact easily with AI tools**

To explore the importance of each imperative and to learn more about Cognizant's approach to building a practical and scalable roadmap to AI, read on.

Introduction:
An AI-powered factory of the future

Recent accelerated developments in artificial intelligence (AI) have captured the imagination of manufacturers. As factories strive to boost productivity, increase resilience, and respond in real time to disruption, AI and automation are no longer optional—they are foundational. In fact, more than half of manufacturers surveyed in a recent Cognizant study said automation investment is a core part of their marginal strategy and a key driver of future growth[3].

Beyond near-term gains, the opportunity is broader:

Another research suggests gen AI could unlock up to $1 trillion in annual productivity gains across industries by 2032[1]. But with competitors already accelerating their AI journeys, the question for manufacturers is no longer whether to act—it's how quickly to scale.

AI has the capacity to expedite digital transformation, a shift already well underway in smart factories around the world. With the right deployment strategy, AI-powered manufacturers can move faster, operate more efficiently, and outpace the competition.

For some, AI offers increased agility and the opportunity to capture greater market share. For others, it provides a way to cut costs and drive productivity gains, ultimately bolstering bottom-line performance. There is no single playbook—every factory operates within its own unique footprint of data, systems, and priorities. But across the board, AI presents significant competitive advantages for those ready to act.

The reality for many, however, is that AI is evolving faster than organizations can adopt it. Significant barriers remain—most notably a lack of visibility or the right tools to access and utilize data. On average, around a third of factory assets are still legacy equipment[2], generating little or no usable information.

To deploy AI effectively, companies must unlock this data to gain visibility across their operational technology stack, but that's only part of the equation. As manufacturers bring a wave of new, data-producing sensors and devices online, they must also address rising cybersecurity risks. The threats are real and so are the implications.

It's also important to recognize that AI remains a nascent technology. Businesses must ask: What comes next? While gen AI dominates headlines today, we're already moving into the era of agentic AI—where autonomous agents will take more action on our behalf, with minimal human intervention.

Are we ready for this shift? What does it mean for the workforce—especially those whose roles haven't yet been automated? And how can they effectively engage with new AI-powered tools?

Before any organization commits millions to AI deployments, these questions must be addressed. This paper outlines five imperatives that business and technology leaders should follow as they chart a practical, secure, and scalable path to AI adoption. We hope you find the guidance provided useful as you enable your factory of the future.

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[1] Cognizant and Oxford Economics report
[2] Visual Components & Vitreous World
[3] Cognizant Journey to Smart Manufacturing and beyond

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Imperative #1:

Let business priorities lead technology decisions

AI's rapid evolution has created enormous excitement and a surge of investment as enterprises look to unlock productivity and innovation gains. But enthusiasm alone doesn't ensure impact. According to research by Cognizant and Oxford Economics, only 26% of companies have successfully implemented gen AI at a cross-enterprise level, revealing the operational and organizational barriers that still stand in the way of scale.

The majority of business leaders aren't adopting gen AI for experimentation—they're pursuing it to drive top-line impact. In fact, 77% of executives cite revenue growth as a key driver for their gen AI investments. For manufacturers, this underscores a critical truth: Value creation doesn't start with the technology, it starts with the business problem.

Leaders should resist the urge to deploy AI for its own sake and instead prioritize clear, measurable outcomes. Aligning AI initiatives with enterprise goals, be it reducing downtime, improving throughput, enhancing decision-making—sets the foundation for meaningful, scalable transformation.

Depending on the goals, be that to increase market share, improve brand reputation, or grow profit margins—technology deployments need to vary. By examining the specific goals mentioned above, we can illustrate how AI-enabled solutions should be selected based on specific strategic priorities.

26%
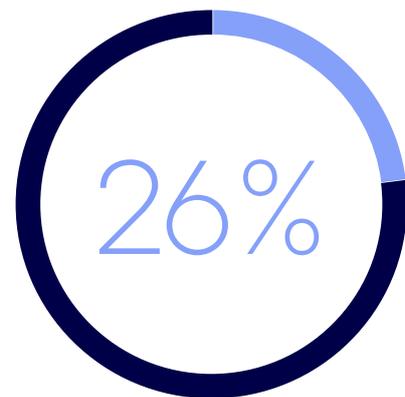
Companies have successfully implemented gen AI at scale across the enterprise.

77%
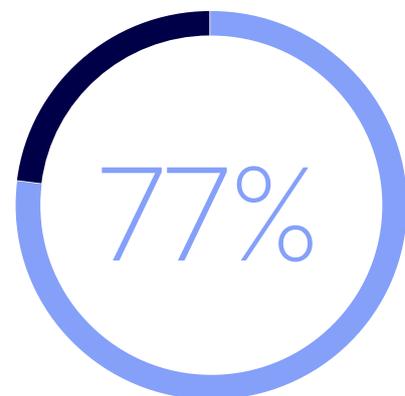
Executives cite revenue growth as the primary driver for their gen AI investments.

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Market share

If a business wants to maintain or grow market share, it will need the capability to quickly respond to changing demand and fulfill these orders. This may lead it to explore different AI-enabled solutions, such as:

- New product introduction: enable a more agile and responsive manufacturing infrastructure that can be reconfigured to meet new demands.
- Supply chain and asset tracking. By deploying technologies like digital twin for simulation and modeling, manufacturers can improve flexibility in layout planning and adoption, helping to identify and remove bottlenecks and adapt the production lines to changing customer demands.

Brand reputation

Any organization looking to boost its reputation in the eyes of customers, employees or investors will want to address corporate responsibility and employee well-being. AI-enabled solutions can also help here. Solutions may include:

- Energy management. Companies can take ownership of sustainability by adopting carbon accounting to help them reduce their carbon footprint.
- Health and safety monitoring. Improve worker well-being by detecting hazards or tracking vital signs that indicate fatigue or injury.

Higher yield with better margins

When companies consider the yield in comparison to the bottom line, they frequently aim to increase profit margins by delivering more with less and reducing levels of waste. AI can help companies to achieve those targets through solutions such as:

- Process optimization. This can help to improve efficiency and reduce materials consumption while increasing yield and throughput.
- Quality management. Identify and remedy defects at an early stage to increase compliance, reduce waste, cut customer complaints, and product returns.
- Predictive maintenance (PdM). By reducing unplanned downtime, manufacturers can increase reliability and plant output, minimize revenue leakage, and ultimately achieve higher production with better margins.

Business drivers	Goals	AI-enabled use case
Market share	Flexibility	New Product Introduction
	Resilience	Supply chain and asset management
Reputation	Corporate responsibility	Energy management
	Employee well-being	Health and safety
Increase margins	Lower inputs and increase outputs	Process optimization
	Reduce waste	Quality management
	Reduce downtime	Predictive maintenance

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Making the business case

As with any technology implementation, the process can be disruptive to operations and working practices. It may be impractical for a business to roll out multiple AI projects simultaneously. That's why it's essential to build a business case for each initiative before deciding which to prioritize.

To evaluate the potential return from each solution, the first step is identifying which KPIs will make the investment worthwhile.

For example:

A company might calculate that real-time process optimization could reduce the annual cost of goods sold by

17%

Resulting in **$3M in savings from a $1M project** and delivering a threefold return within two years.

In another case, a PdM project might reduce downtime by

23%

This improvement could increase throughput and boost revenues by **$4.4M based on a $1.1M investment**, yielding a fourfold return on investment in the same time period.

Business goals	Reduce downtime
AI-enabled use case	Predictive maintenance
Operating metrics	1,833 lost hours p.a. $12,000 hourly cost of lost production
Economic impact	Prevention of $22M of potential revenue leakage
Improvement opportunity	20% reduction in downtime. Throughput hours gained = 367
Value potential	$4.4M in potential new revenue

This type of comparative calculation can help make a strong business case and guide a business on what AI-enabled project they should implement first.

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Imperative #2:

Bring together data from new and legacy assets

Every AI solution relies on access to data. This can pose a challenge to manufacturers, especially if they are reliant on legacy technology.

It's estimated that around 30% of all factory plant assets produce no accessible data[1].

If almost a third of a factory's operation remains "in the dark", offering no visible information, it is impossible for any AI solution to fulfill its potential. To remedy this situation, businesses either need to replace legacy technology or, perhaps more likely, retrofit existing equipment with compatible latest solutions including sensors to gather the necessary data.

Connecting all machinery only solves part of the challenge, however. The extracted data must be converted into a usable format that can be analyzed centrally. This will typically require the adoption of a unified namespace (UNS) approach.

Plant connectivity and UNS

UNS has played a key role in many digital transformation initiatives in the IT sector and is now broadly accepted in the manufacturing sector. The approach adds a layer of data management technology that helps to standardize high-speed and high-volume data coming from various devices and industrial control systems, such as supervisory control and data acquisition (SCADA) systems and programmable logic controllers (PLCs).

This approach creates a seamless data flow for a manufacturing execution system (MES), which typically runs at a lower speed and at lower volumes. It is then easier to connect legacy equipment and manage platforms operating at scale.

UNS also enables richer contextualization of the data. This could, for example, make it easier for an AI solution to highlight the root causes of any issue. Without this, an end user may need to search through layers and layers of real-time dashboards to find the information they need.

With data monitoring in place, it will be possible for companies to have full visibility over their operations. This will enable businesses to create digital twins and use AI to simulate scenarios that can address constraints and bottlenecks in plant operations and supply chains. It would also enable comparisons across manufacturing networks—making the benchmarking of machinery performance, production lines, plants and supply chains possible.

[1] Visual Components & Vitreous World

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Technical advantages of unified namespace (UNS)

Real-time data flow.
Allows instant visibility over production metrics across all manufacturing and enterprise systems, enabling proactive decision-making.

Eliminating silos.
Integrates systems (ERP, MES, SCADA, PLCs, etc.) and enables data standardization across multiple sites, making comparisons of assets and plants easier.

Reliability and scalability.
MQTT-based architecture ensures data is not lost in transit. It is also proven to support massive-scale deployments, without performance degradation.

Bandwidth efficiency.
Allows data filtering, transformation and aggregation at the edge, significantly reducing network bandwidth costs and cloud storage expenses.

Automation and AI/ML integration.
A real-time event-driven architecture enables an AI/ML model, predictive maintenance system or digital twin to act instantly, using contextualized data.

Security and data governance.
Provides fine-grained access control, authentication and end-to-end encryption, ensuring secure data distribution.

Vendor-agnostic and future-proof architecture.
Works with any cloud (on-premises or hybrid) without vendor lock-in, providing flexibility based on the use case and business strategy.

Edge and cloud

Businesses will also need to consider where decisions will be made, as additional infrastructure may be required onsite. For example, if a health and safety system requires the AI to step in instantly when danger is detected, it would be better to deploy edge computing to achieve lower latency and enable near real-time decision-making.

Businesses may also want to consider edge computing if they do not want to rely on external telecommunication networks. They may have a need to air gap critical systems or reduce the connectivity costs associated with processing very large amounts of data every second.

Even if an edge solution is required, any AI solution will also need the support of cloud computing. As a minimum, a cloud platform will be required to train the AI model—its ability to access scalable computing power and additional resources on demand makes it the best choice for heavy analytics.

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Case study

Enabling a multinational manufacturer to reduce production delays

A Cognizant customer wanted to reduce production delays, but was unsure how to do this. Unable to see key metrics, such as the organization's overall equipment effectiveness (OEE), the team was struggling to identify where it had issues and how these could be resolved.

We worked with the customer to access equipment data and gain real-time visibility over operations. We did this by retrofitting factory assets with sensors and integrating data from existing shop floor sensors and PLCs on the Azure IoT platform via a Kepware edge gateway. Using a standardized approach, we rolled out use cases in a matter of weeks, while simultaneously providing training to users, helping them to understand and adopt the solution.

The solution has provided 100% automation of data acquisition and allowed the company to analyze its operations, leading to a reduction in production inefficiencies through the reconfiguration of thresholds and shift schedules. This has enabled the organization to improve production uptime by 2%–5%, reducing production delays.

100%
automation of data acquisition

improved production uptime by
2%–5%

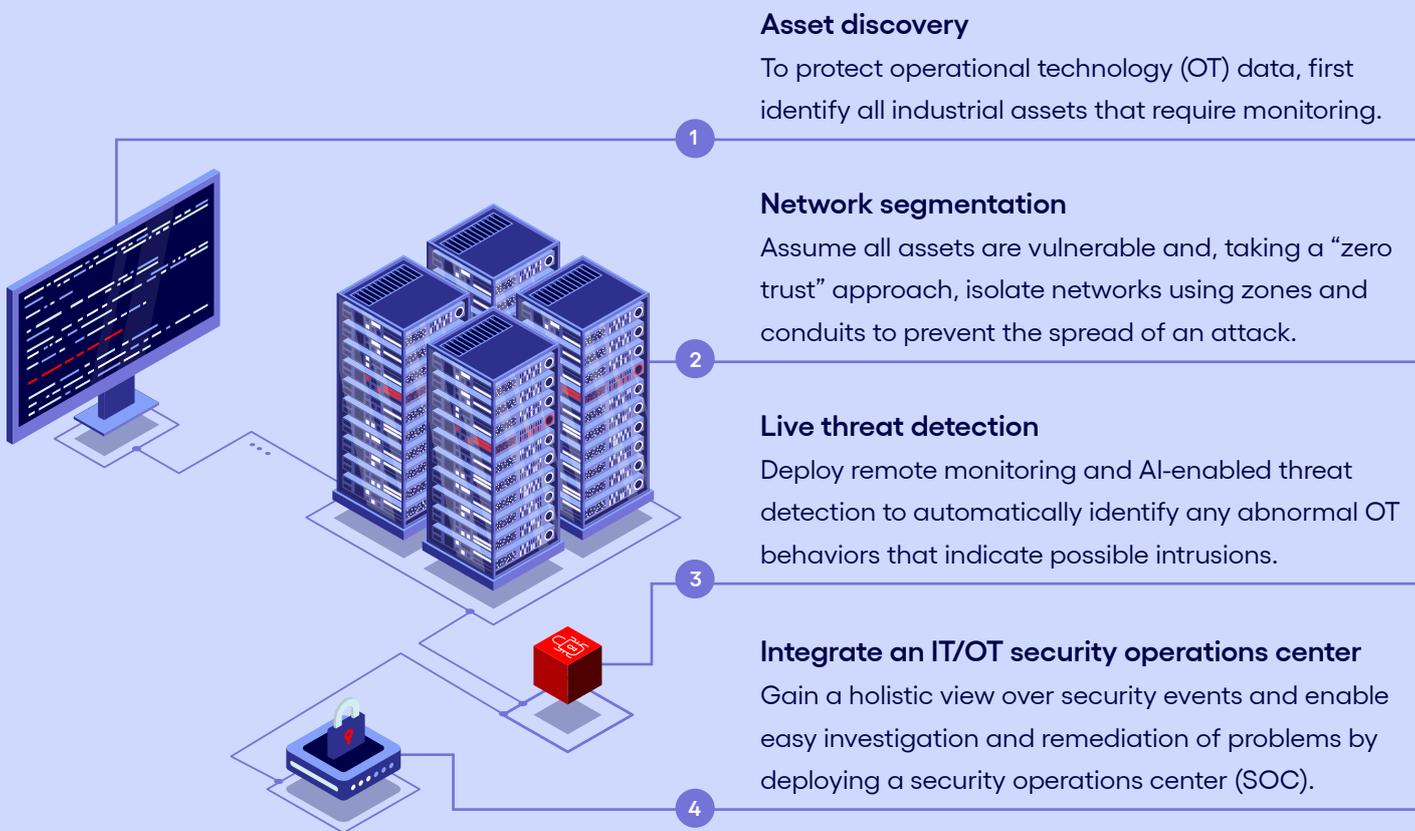cognizant

Imperative #3:

Embed cybersecurity from day one

Cybersecurity has to be a crucial consideration for any business that is expanding the number of connected devices in its operation. Every AI solution is dependent on data, but with every new sensor we connect the potential attack vectors grow.

If this enables a malicious actor to gain access to a network, it can have serious implications for a manufacturer, especially if production is shut down as a result. A loss of revenues and missed orders could be extremely damaging from both a financial and reputational perspective.

To prevent these incidents, AI solutions should be rolled out with security prioritized at all times, with emphasis placed on four key steps.

1 **Asset discovery**
To protect operational technology (OT) data, first identify all industrial assets that require monitoring.

2 **Network segmentation**
Assume all assets are vulnerable and, taking a "zero trust" approach, isolate networks using zones and conduits to prevent the spread of an attack.

3 **Live threat detection**
Deploy remote monitoring and AI-enabled threat detection to automatically identify any abnormal OT behaviors that indicate possible intrusions.

4 **Integrate an IT/OT security operations center**
Gain a holistic view over security events and enable easy investigation and remediation of problems by deploying a security operations center (SOC).

Even with the best cybersecurity policies implemented, no business should assume that it is safe from malicious actors. A clear disaster recovery action plan must be in place, should the worst happen. This should include a business impact assessment outlining the risks in the event that an AI-enabled solution becomes compromised and steps are needed to minimize the damage and to restore operations.

Scale your AI implementation with cybersecurity

As AI is rolled out across an organization, it's critical that cybersecurity measures are a key element of the deployment. Security should be embedded in the implementation roadmap at the start of any project, including the retrofitting or integration of sensors on plant equipment.

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Imperative #4:

Prepare for autonomous AI agents

We are currently in a period when the capabilities of AI are progressing rapidly. Gen AI has demonstrated the potential to rapidly deliver insight that can enhance the performance of a smart factory. However, we are entering an era of agentic AI, where AI agents will be able to take action with minimal human intervention.

For example, if an agent is deployed to protect workers in hazardous environments and it detects a buildup of noxious gas, it would be able to automatically adjust the settings on a HVAC unit to improve the air quality.

Characteristics of agentic AI systems

Specialization.
Agents are designed to perform specific tasks, from simple repetitive actions to complex problem-solving.

Goal-driven behavior.
Agentic AI can manage multistep problem-solving to achieve a specific goal. For example, in the life sciences sectors, agents can build an understanding of regulations, organizational data, and existing content to generate standard operating procedures (SOPs).

Proactive actions.
Agents can monitor and proactively perform tasks. For example, a system can proactively run business workflows, assess the impact of an issue on the shop floor and suggest necessary mitigations.

Autonomous decision-making.
Systems can analyze data and make decisions on their own. By looking at security incidents, real-time data, and external threat systems for instance, an agent could identify and mitigate a cyberattack.

Self-improvement.
Based on past results and data, and using methods such as reinforcement learning, agentic AI systems can improve their own performance over time.

Alternatively, if an agent was deployed to optimize production line throughput, and it detected conditions in the factory had changed due to rising temperatures, it could automatically adjust the parameters on machinery to manage the workload placed on specific components.

If a business wanted to improve just-in-time inventory management, it could also deploy an agent to automatically adjust orders being placed with suppliers, when necessary.

Scaling agents

Similar to automated guided vehicles operating within a warehouse environment, these agents will be able to operate autonomously, making decisions in real time based on their training and learned experiences. They will monitor their environment and adapt to new data inputs. As such, the availability of clean, accurate data in a format that agents can understand will be crucial.

While each agent's actions will be based on a specific goal, the longer-term vision is for agents to communicate and share information among themselves. For example, the agent managing production optimization might collaborate with agents managing inventory management and predictive maintenance.

The rollout of agents will not be a quick process, however. Businesses should initially conduct pilot programs in ring-fenced environments. Once tested and trusted, they can then be scaled out across more production lines and plants.

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Imperative #5:

Enable workers to interact easily with AI tools

While AI agents will be transformative for smart factories, it will not be possible to automate all tasks. Humans will continue to have a key role in production environments, but AI can and will enhance their capabilities.

When a machine operator requires crucial information or insight, gen AI can quickly provide the answers needed to improve performance. These solutions can supply critical data and alert workers to changing parameters so they can take appropriate actions.

For example, a connected worker wearing AI-enabled personal protective equipment could have figures indicating rising temperatures or deteriorating air quality flash up on a visor, giving them time to react to a potentially hazardous situation.

Human UX

When AI-enabled solutions communicate information to workers, who could be simultaneously carrying out a task or operating heavy machinery—consideration must be given to the user experience (UX). The context of this work should determine the design of the human-machine interface (HMI). For example, would it be best to include augmented reality or voice commands, or would a dashboard suffice?

Whatever solution is chosen, the HMI will need to be intuitive and easy to use. This will encourage employee acceptance and minimize the amount of training required before deployment. The UX design should also ensure that information is easy to interpret so it does not slow workers down or become overly distracting.

Organizational change management (OCM)

The introduction of any new technology is likely to impact workers' individual roles and processes, so organizational change management should also accompany any AI implementation project. When doing so, it is advisory to include these five actions:

Stakeholder engagement and communication	Engage with stakeholders early and maintain open lines of communication throughout the project. This helps to manage expectations and address concerns promptly.
Advisory framework	Utilize the Industry 4.0 (I4.0) technologies advisory framework. This includes best practices guidance on how to conduct plant maturity assessments, identify and prioritize use cases, establish a roadmap and ROI.
OCM and support plan	Create a playbook on how to deploy solutions across plants, lines and assets, along with guidance on how to provide lifecycle support.
Training and adoption	Provide comprehensive training and support to employees to ensure they are well prepared to adopt new technologies and processes. This includes creation of training materials and the delivery of workshops—in their preferred language.
Continuous improvement	Implement a continuous improvement approach. This will identify areas for enhancement and enable necessary adjustments throughout the project lifecycle.

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From Vision to Reality: The Roadmap to a Future-Ready Factory

Guided by gen AI and multi-faceted transformation initiatives, manufacturers can clearly navigate the path to smarter, more resilient operations.

	1 Digitization 6–12 months	**2** Digitization 1–2 years	**3** Digital transformation 3–5 years
Technology Analytics	Information modeling Paper on glass Compliance records Reports and dashboards	Automated batch release Gen AI based assistance Analytics platform Manufacturing data lake Golden batch analysis RPA	Complex simulation models Gen AI based decision making Dynamic scheduling
Technology Internet of things	**Digital enablers in place:** • Cybersecurity • Connectivity • Cloud IIoT and sensor deployment IT-OT convergence	Connected worker Technology rationalization & integration AR / VR Unified Name Space, MSB APM	**Digital Twin:** • Simulation • Nerve center Next gen warehouses
Ways of working	Data flows digitalization Digital transformation team Execution standardization Value added task focus	Data science based decisions Process, equipment and safety predictability Predictive maintenance in core assets	Automated decision making Autonomous and regenerative factory
Ecosystem	**Strategic Partnerships:** • Omron • NVIDIA • AWS • Microsoft Manufacturing product vendor relationship	Market and demand data integration Worker safety and sustainable working environments	Data interchange and integration models

4 **Smart Factory End-Vision**

Conclusion—Key takeaways

Five imperatives for manufacturing transformation

1. **Let business priorities lead technology decisions**
2. **Bring together data from new and legacy assets**
3. **Embed cybersecurity from day one**
4. **Prepare for autonomous AI agents**
5. **Enable workers to interact easily with AI tools**

The ability of AI to accelerate transformation within a smart manufacturing environment is an exciting prospect. But, with so many potential deployment avenues, it's critical that clear business goals guide decisions.

If companies ultimately want to scale these deployments across plants and sites, they must build on proven pilots. The success of those projects will depend on several factors, including the ability to gain visibility across all operational technology, and then standardize and secure the data it generates.

Steps will also be required to prepare for further AI deployments, including the introduction of autonomous agents and enabling human workers to interact effectively with these new solutions.

With all these elements taken in place, businesses will be well positioned to maximize AI's potential, and will have started building a roadmap to their factory of the future.

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Build your roadmap with Cognizant

As a recognized leader in digital engineering and industrial operations, backed by a global delivery network and an ecosystem of strategic partners, Cognizant helps businesses modernize, optimize, and scale their industrial operations with AI-powered automation.

Cognizant's partnerships with OMRON, AWS, NVIDIA, and more, combined with our Industry 4.0/5.0 capabilities, enable us to approach transformation from both top-down and bottom-up. We bridge IT and OT by enabling real-time data exchange, unified management, and advanced analytics—leading to smarter, more agile, and secure manufacturing operations that serve as a foundation for leveraging AI effectively. From edge intelligence and industrial automation to AI model acceleration and cloud-native platforms, these alliances power real-world transformation across operations, quality, and supply chains.

Using a proven toolkit based on best practices and design principles from 50 Fortune 500 clients, Cognizant helps define your strategic smart manufacturing vision. Our best-in-class Cognizant OnePlant® methodology and framework can quickly identify how digital technologies can improve your production operation, while benchmarking you to the market.

We then apply the right IT and OT technologies, along with our pre-built accelerators, to increase productivity and predictability. Our solutions scale from one production operation to many globally diverse locations.

To support this journey, Cognizant's global network of specialized labs, including smart manufacturing innovation labs, engineering R&D centers, and industry-grade testing facilities, brings together cross-functional teams to solve real problems in real time. Located across India, Germany, Japan, Poland, and North America, these hubs offer hands-on access to emerging technologies and expert guidance. By enabling rapid prototyping and tailored innovation, supported by our partner ecosystem, we help manufacturers de-risk transformation and accelerate time-to-value—turning strategic vision into executable impact.

Let's talk next steps

Whether you're scaling AI pilots, optimizing a single plant or rethinking your global production model, our experts are here to help, from strategy to execution.

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